are renewed by accession of lower soil to the plowed portion.

For the purpose of conducting investigations of this kind there have been built on the farm at Cornell University a number of large tanks in which soil may be kept at the same surface level, and under conditions nearly identical with that of the surrounding soil, upon which duplicate tests are made. They are intended to furnish receptacles for bodies of soil of sufficient size to produce plants in a normal manner under approximately field conditions, and yet afford opportunity for measuring a large number of the factors affecting plant growth. The construction is of concrete, but the tanks will be lined.

Each tank is four feet two inches square with a maximum vertical depth of four feet six inches and a minimum depth of four feet. There are twenty-four tanks placed in two rows of twelve tanks each. Between the rows of tanks is a tunnel, the bottom of which is ten feet below the top of the tanks. The tunnel is six feet wide. From the lowest point in each tank is an outlet tube two inches in diameter and tin lined. It is made large enough to permit of easy cleaning and has no bends in it. A piston runs through the tube to within four inches of the upper end. Between the perforated head of the piston and the soil, glass wool is to be inserted. The piston can be withdrawn if it is desired to clean the tube.

Drainage water from each tank will be caught in a receptacle in the tunnel. The lining in the tanks will prevent any soluble material in the concrete from appearing in the drainage water. A constant water table at any desired depth may be maintained by raising the rubber tube leading from the outlet tube to a corresponding point below the surface of the soil in the tank.

The tanks, as described, will each contain between three and four tons of soil, and the surface will constitute approximately .0004 of an acre. They are built with special reference to durability so that it will be possible to plan for experiments to extend over a long period. The quantity of soil contained is not too large to allow of accuracy in sampling and yet is sufficiently large to closely resemble field conditions, which is not true of the quantity contained in pots. No covering is to be placed over the tanks, but in every way natural conditions are to be permitted. The top soil and subsoil will be placed in their relative positions. It is expected that the rainfall will be sufficient to meet the needs of the crops, but if the plants suffer during periods of drought they can be watered artificially.

Any desired type of soil may be used which is not possible with ordinary field experiments. It is also possible to make a comparison of different soil types under any desired condition which may be very serviceable in ascertaining the effect of those properties differentiating these types upon certain factors in soil productiveness.

The chief feature of the plan is that of keeping accurate records of the factors affecting plant growth without producing artificial conditions.

The tube leading from the bottom of the tank is designed to carry off the drainage water into a receptacle which will permit the quantity to be measured and its constituents to be determined.

The accompanying diagram shows the plan and cross-section of these tanks.

T. L. LYON

THE GEOLOGICAL SOCIETY OF AMERICA

THE twenty-first annual meeting of the Geological Society of America was held under the presidency of Professor Samuel Calvin, of Iowa City, Iowa, in the rooms of the geological department, Johns Hopkins University, Baltimore, Tuesday, Wednesday and Thursday, December 29, 30 and 31, 1908.

The first session of the meeting was called to order at ten o'clock Tuesday morning with President Calvin in the chair and the society was cordially welcomed to Baltimore by Professor W. B. Clark in a few well-chosen remarks, to which appropriate response was made by President Calvin.

The secretary, Dr. E. O. Hovey, of the American Museum of Natural History, reported that the printed list of fellows contained 294 names, the

same as at the time of making the last annual report. During the year the four new fellows elected at the Albuquerque meeting qualified; two fellows, Homer T. Fuller and William S. Yeates, were lost by death, and two by resignation. After presentation of the memorials of the deceased fellows the regular program of papers was taken up as follows:

The first paper read was:

Some Distinctions between Marine and Terrestrial Conglomerates: JOSEPH BARRELL, New Haven, Conn.

The problem was approached by studying the effects of shore, as compared with subaerial, activities upon the production, transportation and deposition of gravel. It has been found that the truly terrestrial forces produce vastly more gravel, spread it far more widely, and provide more opportunities for deposition, than do the forces of the littoral zone. Conglomerate formations, therefore, should be dominantly of terrestrial origin. In order to determine, however, the mode of origin of particular examples, definite criteria must be drawn between the two classes. It was shown that the thickness was one of the most important of these marine conglomerates, except under local and special circumstances, being limited to considerably less than one hundred feet in thickness, terrestrial conglomerates, on the other hand, being frequently measured in hundreds and occasionally in thousands of feet.

Attention was next turned to the significance of the intercalated non-conglomeratic beds and the relations to the under- and over-lying formations, with the conclusion that the characteristics of the associated strata are frequently of high supplemental value for determining the mode of origin.

Applications of the conclusions were made to several conglomeratic formations.

Professor Barrell's paper was discussed by Messrs. G. K. Gilbert, J. Barrell and W. H. Hobbs.

The following papers were read by title:

The Chemistry of the Pre-Cambrian Rivers: REGINALD A. DALY, Boston, Mass.

The Primary Origin of the Foliated Structure of the Laurentian Gneisses: FRANK D. ADAMS and ALFRED E. BARLOW, Montreal, Canada.

Relations of Present Profiles and Geologic Structure in the Desert Ranges: CHARLES R. KEYES, Des Moines, Iowa.

Deflation and the Relative Efficiencies of Erosive Processes under Conditions of Aridity: CHARLES R. KEYES, Des Moines, Iowa.

Then were read:

Unconformity Separating the Coal-bearing Rocks in the Raton Field, New Mexico: WILLIS THOMAS LEE, Washington, D. C.

The coal-bearing rocks of northern New Mexico in the vicinity of Raton occupy the southern part of the Raton Mountain region. The rock formations are the same as those of the Trinidad coal field in southern Colorado, heretofore referred to the Laramie. Recent work in the Raton field has proved that there are two coal-bearing formations separated in time by a period of erosion. The evidence of the hiatus is found: (1) in the partial removal of the older beds, (2) in the character of the pebbles found at the base of the younger formation, (3) in the affinities of the fossil plants.

Evidence that the Appalachian and Central Coal Fields were once connected across Central Kentucky: ARTHUR MILLER, Lexington, Ky.

In support of the view long entertained, that the different Carboniferous coal fields of the United States were formerly connected, the writer during the past summer found deposits of Coal Measure conglomerate in a narrow band along the watershed between the Green and Salt rivers, and in previous years had noted it between Bacon Creek, a tributary of Nolin River, and Green River; and also on the top of King's Mountain, near the head of Green River. During most of this stretch it forms the crest of Muldrow's Hill. It consists of massive bowlders of large quartz pebble conglomerate and great banks of pebble and sand waste. It has contributed much material to the lands lying south of Muldrow's Hill, giving to many of them a sandy character. It itself, near the middle of its course, is deeply dissected, resembling in its topography, soils and population, the same formation in eastern Kentucky.

The Bearing of the Tertiary Mountain Belt upon the Origin of the Earth's Plan: FRANK BURSLEY TAYLOR, Fort Wayne, Ind.

Suess showed with great clearness and force that the peripheral mountain system of Asia was formed by horizontal thrust movements from the north; *i. e.*, from the interior of the continent towards the ocean.

In the present paper the following points are dwelt upon as tending to confirm Suess's generalization and the writer's extension thereof:

1. The Tertiary mountain arcs and island festoons of Asia bulge outward towards the south, showing southward crustal creep of the continental mass.

2. The Himalaya mountain range exceeds others in height, because it was so severely pressed against the north side of the older plateau of

India. The Malay arc, lapping around the eastern end of the Himalaya and swinging far to the south—even beyond the equator—met no such obstacle. It spent itself more freely and formed the most remarkable of the great earth-lobes of Asia.

3. At its eastern end the tectonic line of the Aleutian island arc penetrates to the heart of the mountain knot of Alaska, so that westward from about the 148th meridian, west longitude, Alaska belongs structurally to Asia.

4. The Tuscarora deep, close in front of the Japan and Kurile Island arcs, and also the long, narrow deep, close in front of the Aleutian arc, mark areas probably in part elastically depressed by the weight of the adjacent more or less overthrust masses. They mark the negative side of these great tectonic lines, while the high, though largely submerged, mountain ranges of the adjacent island arcs mark the positive, uplifted side of the same lines. These troughs are now unfilled, because the uplifted ranges near them have remained largely submerged and hence have supplied little or no sediment.

5. The mountain knot of Alaska was raised to its extraordinary height by a convergence of crustal creeping movements. It is precisely in the angle where the southeastward creep of the Aleutian earth-lobe came into conflict with the southwestward creep of northern North America.

6. The peculiar rift valleys on the northern and western sides of Greenland suggest a rending and tearing away of Grant Land, Baffin Land and Labrador from Greenland, due apparently to crustal creep towards the south and southwest, Greenland remaining as the great northern horst. The import of these several facts added together is Tertiary southward crustal creep, with peripheral faulting, folding and uplifting for all the northern continents.

7. Australia's Tertiary peripheral mountain belt lies in island chains seaward from its northern and eastern coasts, indicating northward and eastward crustal creep. South America's belt is on its northern and western sides, indicating northward and westward creep. Thus, the two southern continents show in general northward creep, but with a considerable amount of deflection.

8. The Celebes and Malmahera islands show remarkable "chiragratic" mountain plans, and they are precisely in the zone of conflict between the southward crustal creep of Asia and the northward crustal creep of Australia. Borneo is in the same zone and has a similar mountain plan.

Conclusions.—The foregoing facts show crustal creep in both hemispheres from high towards low latitudes. This is not explicable by any form of contraction hypothesis, but is the normal result of a force tending to deform the lithosphere by slightly and permanently increasing its oblateness —the same in effect as if the earth's axial rotation had been slightly and permanently increased. No contraction hypothesis can account for the occurrence of this remarkable epoch of mountain making at so recent a time as the Tertiary age, unless it can provide some method of storage of mountain making forces which shall endure and continue to accumulate through several geologic ages, with occasional mountain making in moderate degree going on at the same time.

The action of such a force would cause a depression of both polar areas, resulting in crustal creep towards lower latitudes. Inevitably, one polar area would yield before the other or else in greater amount. The pole from which the first large shift of mass took place would ever after take the lead and be the more active area in crustal movement, for that first movement would slightly displace the earth's center of gravity, moving it towards the other pole, where the shift of mass was less, and this change itself would intensify the deforming forces at the first pole and diminish them at the other. Thus, the first pole, corresponding to the north pole of the earth, would progressively emerge from the sea, would suffer the greater deformation and would therefore have an excess of land or continental areas around it, while the other (south) pole would be progressively submerged, would suffer less deformation and would have a minimum of land or continental areas around it. This may explain why the north pole is girdled by land and the south pole by water.

The forces causing southward crustal creep in the northern hemisphere were strongest in high northern latitudes and diminished towards the south; and further, the area of earth-crust upon which the forces acted increased towards the south. Perhaps these two conditions, modified by the tendency to a limited number of meridional rifts due to girth expansion in the equatorial belt, explain the triangular shape of the continents—broad at the north, where a land belt almost girdles the earth, and tapering in sharp points towards the south.

Mr. Taylor's paper was discussed by Professors H. F. Reid, B. K. Emerson, J. Barrell, W. H. Hobbs, A. P. Coleman and F. B. Taylor.

The session then adjourned at 12:30 P.M.

The society convened again in two sections at

2:10 P.M. The first paper presented in the main section, under the chairmanship of President Calvin, was:

On Faults: HARRY FIELDING REID, Baltimore, Md.

This was followed by

Mass Movements in Tectonic Earthquakes: HARRY FIELDING REID, Baltimore, Md.

These papers were discussed by Professor W. H. Hobbs and H. F. Reid.

The next paper was read by title:

The Alaskan Earthquake of 1899: LAWRENCE MARTIN, Madison, Wis. (Introduced by C. K. Leith.)

The society then listened to

A Recent Landslide in a Shale Bank near Cleveland accompanied by Buckling: FRANK R. VAN HORN, Cleveland, Ohio.

The landslide in question took place at the plant of the Cleveland Brick and Clay Company, beginning Monday, August 17, 1908, at 3 P.M., and lasting until late the following day. The shale bank is about 112 feet high and consists of about 3 feet of drift, 21 feet of Cleveland shale and 88 feet of Erie Chaghn shale of the uppermost Devonian. The bank cracked along the valley for a length of 250 feet and followed weathered joint planes almost entirely. The width of the crevice varies up to 22 feet and the vertical displacement is 6 to 7 feet. The mass broken off has been estimated variously up to a million tons, but one hundred thousand tons is probably excessive. After the crevice reached its widest dimensions, the severed block settled back towards the cliff about 1 foot, producing a noticeable dip of the shale layers, at the same time the valley floor at the base of the cliff buckled up into an anticline 4 to 5 feet in the highest portion and traceable over a distance 200 feet. The buckling continued over a period of two months after the crack formed. Buckling is quite often noticed in shales along the edges of stream valleys and it is possible that such movements have been caused by similar landslides.

This paper was discussed by Professors H. P. Cushing, J. W. Spencer, G. B. Richardson, F. R. Van Horn, G. K. Gilbert and G. H. Ashley.

Then was read by title:

The Volcano Kilauea: C. H. HITCHCOCK, Honolulu, Hawaiian Islands.

After this was presented:

Mt. Pelé of Martinique and the Soufrière of St. Vincent in May and June, 1908: EDMUND OTIS HOVEY, New York, N. Y.

The paper gave the results of an expedition made to the Lesser Antilles in April to July, 1908, illustrating by means of lantern slides the progressive changes in 1902, 1903 and 1908 due to the great eruptions and the efforts of nature and man to recover from them.

The last paper of the afternoon was:

Multiple Glaciation in New York: H. L. FAIRCHILD, Rochester, N. Y.

Evidence of pre-Wisconsin glaciation in territory surrounding New York State—in Canada, Ohio, Pennsylvania, New Jersey and New England, implies a similar history for the state.

An accumulating body of fact points to at least two ice invasions. Such features are: (1) the widespread occurrence of more or less difference between the surficial and the deeper till; as shown in color, texture, composition, with sometimes a distinct surface of separation; (2) weathered glaciated surfaces and heavy glacial flutings merely scraped in places by a later abrasion; (3) old planation surfaces which though protected by Wisconsin till have lost their glaciated character; (4) probable stream channels not the product of the latest glacial drainage; (5) physiographic features of anomalous relationship.

No interglacial deposits have as yet been found.

This paper was discussed by Professor G. K. Gilbert, R. S. Tarr, F. Carney, A. Penck and A. P. Brigham.

Adjourned at 5:25 o'clock.

The society met at 8 o'clock Tuesday evening in the lecture room of the geological department to listen to the presidential address of Professor Samuel Calvin, who chose as his theme "The Latest Phase of the Pleistocene Problem in Iowa." This paper will be published in full in SCIENCE.

At the close of the address, the society and its friends adjourned to the rooms above the lecture hall and participated in a "smoker" as the guests of the geological department of the university, the function closing shortly before midnight.

Wednesday morning the society came to order in general session, President Calvin presiding, at 9:35 o'clock, and after the consideration of some matters of business listened to the reading of a letter from Hon. Gifford Pinchot, chairman of the National Conservation Commission, requesting the appointment of a committee by the Geological Society of America with which the commission might confer regarding geological subjects. It was voted to empower the president to appoint three fellows to act as a committee on conservation.

Then was presented a paper by Professor Albrecht Penck, of Berlin, who had been invited by the council to participate in the meeting. Professor Penck chose as his theme "Interglacial Epochs."

At the close of this paper the special section on correlation withdrew for the continuation of its sessions, and the general section, with President Calvin in the chair, proceeded with the main program.

The following two papers were read:

Glacial Waters West and South of the Adirondacks: H. L. FAIRCHILD, Rochester, N. Y.

As the lobes of the ice sheet melted away south of the Adirondacks, high-level waters were held in the Schoharie and Mohawk valleys, into which was poured the land and glacial drainage of the time, with consequent elevated deltas. The Schoharie Lake had outlets to the Hudson and the Delaware; and subsequently the Mohawk waters overflowed southwestward to the Susquehanna, but finally to the Hudson.

The earliest outlet of the Mohawk Valley waters seems to have been by the col at the head of the Otsego-Susquehanna valley, with elevation somewhat under 1,400 feet. A lower escape was found by the Unadilla Valley, at about 1,220 feet, and possibly by the Chenango Valley at 1,150 feet. Later the outflow was eastward to the Hudson by Delanson and Altamont and past the face of the Helderberg scarp, at 840 feet as the lowest. The latest flow of the ice-impounded Mohawk waters was south of Amsterdam and past the face of the scarp at Rotterdam.

The copious drainage of the western slopes of the Adirondacks poured into a lake held in the valley of Black River, with the production of a remarkable expanse of sand plains. In the various features and relations which characterize a glacial lake the Black Lake is probably the finest example of a glacial lake in the state (though not nearly so remarkable in complexity of drainage and history as the Genesee waters). The earliest outflow of the differentiated waters of the Black Valley was southward past Remsen into the Mohawk Lake, with delta built at Trenton and Trenton Falls. The second escape was southwestward, at Boonville, into the inferior Mohawk Lake, with delta north of Rome. The third stage had westward outflow, curving around the high ground between the Black Valley and the Ontario basin, at Copenhagen and Champion, the flood pouring into Lake Iroquois at Adams.

Correlation of the Hudsonian and the Ontarian Glacier Lobes: H. L. FAIRCHILD, Rochester, N. Y.

In the waning of the Labradorian ice body the Adirondack massif became uncovered, at first as an island, with probable westward flow of the ice through the Mohawk depression. Later the glacial flow was divided into a Champlain-Hudson lobe and a St. Lawrence-Ontario lobe. For a long time the Hudsonian lobe pushed an ice tongue westward into the lower Mohawk valley, while the Ontarian lobe sent one eastward into the upper Mohawk valley. Imprisoned between the two opposing ice fronts the glacial waters stood at high levels in the Mohawk and Schoharie valleys. As the waning ice margins released successively lower passes to southern drainage the waters fell accordingly.

The delta sand plains on the flanks of the Adirondacks and in the upper Mohawk valley, with their various declining altitudes, show the successive levels of the waters; and these levels were determined by the positions of the ice margins with reference to a few critical cols or passes on the divide.

These two papers were discussed by Professors A. P. Brigham, H. L. Fairchild and A. W. Grabau.

The next paper was read by title. It was:

Pleistocene Features in Northern New York: H. L. FAIRCHILD, Rochester, N. Y.

Then the society listened to:

Pleistocene Geology of the Southwestern Slope of the Adirondacks: W. J. MILLER, Clinton, N. Y. (Introduced by W. B. Clark.)

The area discussed in the paper is about sixty miles long and fifteen miles wide and extends from Lowville to Dolgeville, N. Y. Certain evidence clearly indicates an early southeasterly movement of the ice, while other evidence shows a later, more general southwesterly direction of flows. The Black River Valley has been considerably deepened and modified by ice erosion. A distinct kame-morainic belt has been traced the whole length of the area. Associated with this moraine are so-called "sand plains," whose origin is discussed. Extinct glacial lakes are shown by the presence of considerable areas of stratified clay. The pre- and post-glacial drainage of the region and the origin of the "gulfs" were discussed.

The paper was discussed by Professor G. K. Gilbert.

Then was read:

Weathering and Erosion as Time Measures: FRANK LEVERETT, Ann Arbor, Michigan.

The paper aimed to set forth the use that may be made of weathering and erosion in determining relative age of the several drift sheets. It also dealt with the most important qualifying conditions that affect estimates.

At the close of the reading of this paper, at 12:30 o'clock, adjournment was taken, discussion being postponed to the afternoon.

The society convened again at 2 o'clock, President Calvin presiding, and took up the discussion of Mr. Leverett's paper, the participants being Professors A. Penck, S. Calvin, F. Leverett, G. F. Wright and G. K. Gilbert.

The next two papers were then read:

The Glacial Phenomena of Southeastern Wisconsin: WM. C. ALDEN, Washington, D. C. (Introduced by T. C. Chamberlin.)

A graphic presentation by a map 9 × 10 feet, scale one mile per inch, of a detailed study of the deposits of the Green Bay and Lake Michigan glaciers and associated phenomena of late Wisconsin glaciation of southeastern Wisconsin. The map covers an area approximately 8,600 square miles, which has been under study by the author under the direction of Dr. T. C. Chamberlin, during the greater part of the last ten years. The presentation comprised such description as the time permitted of the conditions affecting the advance of the two glaciers, their relations to each other, the character, distribution and mode of formation of the several deposits, terminal and recessional moraines, outwash deposits, ground moraines, drumlins and eskers, the lithological composition of the drift and its significance. Evidence was presented by a deposit of red till of a later readvance of the two glaciers southward to the vicinities of Milwaukee and Fond du Lac. The shore lines and deposits of Lake Chicago and succeeding glacial lakes were also shown.

Concerning certain Criteria for Discrimination of the Age of Glacial Drift Sheets as Modified by Topographic Situation and Drainage Relations: WM. C. ALDEN, Washington, D. C. (Introduced by T. C. Chamberlin.)

The discussion was confined to phases illustrated by the pre-Wisconsin drift of southern Wisconsin and northern Illinois.

Character of this drift and reasons for regarding the drift exposed at the surface throughout this area as belonging to one and the same sheet. The lithological composition and its significance, directions of ice movement, absence of intercalated weathered zones, soils or vegetable deposits.

Differences in the apparent amount of surface modification of this drift in different parts of the area which might be regarded as indicating differences in age:

1. Topographic relations and amount of erosion.

2. Weathering, leaching and oxidation. The occurrence in places of thoroughly disintegrated drift or residual till; in others, of drift but moderately leached and oxidized; in others, of perfectly fresh unmodified drift at the surface or immediately below the loess.

The reasons for these differences:

1. Influence of pre-Glacial topography on drainage slope and upland of the drift. Influence of the St. Peter sandstone on the pre-Glacial topography. Relations of surface wash to the apparent amount of surficial leaching and oxidation.

2. The post-Illinoian diversion of Rock River below Rockford, Illinois, and the consequent retardation of erosion due to the work of cutting new rock gorges at several cols. Removal of the weathered drift from slopes with preservation on the uplands.

Necessity for caution in the discrimination of distant drift sheets in the absence of marked differences in lithological composition or of sections showing overlapping drift with intercalated soils, vegetable deposits or weathered zones.

The two papers together were discussed by F. Leverett.

Then was read:

Lake Ojibwa, the Last of the Great Glacial Lakes: A. P. COLEMAN, Toronto, Canada.

As the Labrador ice sheet retreated north to the watershed between the Great Lakes and James Bay, the waters now flowing northward were impounded, first as a narrow bay of Lake Algonquin opening south past Sudbury, afterwards as a separate lake with an outlet down the Ottawa Valley. This lake probably existed during the time of the Nipissing Great Lakes, and was the last of the ice-dammed lakes. The elevation of its outlet is now 900 feet, but was then much lower. In its bed the "clay belt" of northern Ontario and Quebec was deposited, having an extent of over 25,000 square miles. The maximum area covered by its waters must have been greater than that of Lake Superior; though probably its extent varied greatly in accordance with the position of the ice front.

This paper was discussed by Mr. F. B. Taylor and Professor A. P. Coleman.

The next paper was:

Glacial Erosion on Kelley's Island, Ohio: FRANK CARNEY, Granville, O.

Last summer a rectangular area about 100 rods long and 4 rods wide was stripped to open a new quarry. This area is transverse to the direction of ice-motion; its southern part does not show the slightest evidence of rasping by stone-shod ice. This rough unglaciated surface ends abruptly in a perfectly smooth, scored area which continues about 800 feet, where it again borders limestone bearing no marks whatever of ice-work. The erosion features thus revealed are so in contrast with the long-known glaciated surfaces near by that the case deserves special consideration.

The paper was discussed by Professor G. F. Wright.

Then was read:

The Chalk Formations of Northeast Texas: C. H. GORDON, Knoxville, Tennessee.

Extending in a west to east direction across the southern part of Lamar County and thence northeast through Red River County to Red River and having a width of from one to three miles, is a belt of chalk known as the Annona chalk from the town in Red River County near which it outcrops. In the earlier publications relating to the Cretaceous of Texas, this formation was considered as the diminished representative of the Austin chalk of central Texas. Later authors, however, have contended that it represents a higher horizon and belongs within the so-called Navarro division of the Upper Cretaceous.

Recent investigations by the author, in connection with the study of the underground waters of northeastern Texas, tend to confirm the earlier view as advanced by Taff that the Annona is the northeastward extension of the Austin formation. Tracing the outcrop of the Annona westward it was found to merge with that of the Austin as exposed in the vicinity of Honey Grove and westward to Sherman. At Austin the formation has a reported thickness of about six hundred feet and is composed essentially of chalk throughout. Toward the northeast the lower beds become marly, the thickness of the chalk marl increasing until in the vicinity of Red River the marls have a thickness of about four hundred feet. To this part of the formation, as represented in northeastern Texas and southwestern Arkansas, Hill applied the name Brownstown beds.

The relations seem to indicate that at the beginning of the Austin epoch the conditions for the formation of pure chalk existed only in the region about Austin, but with the progress of time they were extended farther and farther northeast as a result possibly of a change in the relative position of land and sea.

The next paper was read by title:

Geologic History of the Ouachita Region: E. O. ULRICH, Washington, D. C.

After which was read:

Some Results of an Investigation of the Coastal Plain Formations of the Area between Massachusetts and North Carolina: WM. BULLOCK CLARK, Baltimore, Md.

The author has under his supervision for the U. S. Geological Survey the investigation and correlation of the coastal plain formations occupying the territory between Massachusetts and North Carolina, inclusive, and has had associated with him in his work a number of co-workers. Some preliminary results of significance have been secured and the formations already studied in detail in New Jersey, Delaware and Maryland have been traced beyond the borders of those regions. The extension of certain of these formations southward through Virginia and North Carolina and the recognition of new members of the coastal plain series have materially added to our knowledge of coastal plain geology. Some of the more significant results of this work were presented.

This paper was followed by the reading of:

The Geologic Relations of the Cretaceous Floras of Virginia and North Carolina: EDWARD W. BERRY, Baltimore, Md. (Introduced by Wm. B. Clark.)

The evidence of the fossil plants concerning the geologic segregation and correlation of the Cretaceous of the Middle Atlantic Slope was presented by the author. Floras similar to those of the adjoining region to the northward have been found at many localities, indicating the extension to the southward of a number of the formations.

The special section on correlation having adjourned, the society then listened in general session to the following papers:

Paleogeography of North America: CHARLES SCHUCHERT, New Haven, Conn.

The ancient geography of North America, beginning with the Cambrian, was discussed and illustrated by from forty to fifty maps of as many different times. These maps give the probable extent of the marine inundations over the North American continent, and show the extent of the faunal provinces.

The diastrophism indicated by these maps is plotted on a time-geographic curve to show the

extent and duration of the periodic submergences and emergences.

The paper was discussed by Mr. B. Willis.

Revision of the Paleozoic Systems in North America: E. O. Ulrich, Washington, D. C.

Following a brief statement of current and earlier classifications of the Paleozoic rocks and of the evidence, almost solely paleontologic, upon which the present classification is founded, a new grouping of the formations was suggested. The proposed classification is based primarily on crustal movements, diastrophism, the succession of which is determined by the faunal evidence. The occurrence of such movements is determined, aside from plain physical evidence, primarily by mutations in the faunas, especially by the introduction of new faunal elements and facies, and their relative importance by (1) the extent and direction of the submergences and emergences of landmasses induced by the movements and (2) the degree of the corresponding faunal mutations. In determining the boundaries of the various kinds of units, formations, groups, series and systems, the *introduction* of the new faunal elements is insisted on as an essential factor, second in importance only to positive evidence of crustal movements, in producing a scheme of classification having the desirable features of (1) simplicity of arrangement and expression, (2) sharp definition of the major groups, (3) approximate coordination in time values of the various classes of units, (4) a high degree of accuracy in correlation of geographically separated stratigraphic units and (5) the elimination of such hybrid terms as Cambro-Ordovician and Devono-Mississippian. An attempt was made to express the extent and direction of submergences and emergences graphically by a series of curves which it is believed show an appreciable rhythm in occurrence. Considering that the evolution of the scheme involves the determination of the essential contemporaneity of many hitherto not satisfactorily related geologic events, some time was devoted to the discussion of such of the principles of correlation as have been proved by field experience to have the greatest practical value.

Among the changes proposed, the most important is a new system, the Ozarkian, comprising a number of long-misunderstood formations, typically represented in southeastern Missouri and northern Arkansas, but found also in the Appalachian Valley from New York to Alabama, in the upper Mississippi Valley, in Oklahoma, central Texas and elsewhere. Both the upper and lower boundaries of the Ozarkian are defined by more or less marked unconformities. Often the base is in contact with Acadian Cambrian, but at other localities a series of beds or formations, commonly referred to as "upper Cambrian," intervenes.

The top is succeeded by one or another of a great range of formations. In the most complete sections the next strata are of Beekmantown age, in others, however, the succeeding bed is much younger. Concerning the fauna of the Ozarkian, it is to be said that the trilobites and brachiopods, though all new, remind one strongly of preceding Cambrian types. The other classes, among them a host of gastropods and cephalopods, are quite different and on the whole closely allied to Ordovician genera and species.

Suggested changes of comparatively minor import were (1) the correlation of the Richmond with the Medina and, hence, the removal of that group to the Silurian; (2) the restriction of the Devonian to the lower and middle Devonian of current classifications and the transfer of the upper Devonian to the next younger system; finally (3) it was argued that the Meramec and Chester groups of the present Mississippian constitute another system coordinate in value to the Silurian and Devonian.

Mr. Ulrich's paper was interrupted by adjournment at 5:45 P.M. and the reading was finished on Thursday. It was discussed by Professor A. W. Grabau.

At 7 o'clock Wednesday evening the fellows and their friends, to the number of 133, gathered at the Hotel Rennert and sat down together at the annual dinner of the society. President Calvin presided, and, after dinner, remarks were made by him and Messrs. Gilbert, Penck, W. B. Clark, G. O. Smith, Brock, Chamberlin, Hovey, Gulliver, Van Hise, Emerson and Stevenson.

The society convened again at 9:45 o'clock Thursday morning, President Calvin being chairman, and after hearing sundry announcements by the secretary listened to the reading by the secretary of the following report from Professor T. A. Jaggar, Jr., chairman of the committee on earthquake and volcano observations:

"Acknowledgments have been received from the governors of the Leeward Islands, of Hawaii, of Jamaica and of St. Thomas, from the chairman of the Isthmian Canal Commission and from the secretaries of the Smithsonian Institution and of the committee on seismology of the American Association for the Advancement of Science.

"Hon. W. F. Frear, governor of the Hawaiian Islands, writes:

"'Hawaii is an important point for observations of this kind, but how much can be done in this direction is a question. I shall be glad to give what encouragement I can in this matter. The federal government now has a magnetic observatory here, which also contains a seismograph.'

"Wm. Johnstone, Esq., colonial secretary of Jamaica, writes:

"'In reply I am to state for the information of the society that the Weather Service of Jamaica has already in use two seismometers in this island, one at Kingston and one at Chapelton, about the center of the island, and that there are now being constructed here about a dozen seismometers on an improved principle.'

"Col. Geo. W. Goethals, chairman and chief engineer of the Isthmian Canal Commission, writes:

"'We have now at Ancon, Canal Zone, an observatory equipped with a complete assortment of modern, self-recording meteorological instruments, *i. e.*, barograph, air and water thermograph, hydrograph, baragraph à poid, triple register (wind direction and velocity, rainfall and sunshine) and the standard instruments necessary properly to correct their records. We expect shortly to erect two horizontal pendulum Bosch-Omori seismographs—one a hundred-kilogram pendulum instrument (tromometer), which will enable us to obtain registered records on smoked paper of all movements of a telluric nature, either seismic or otherwise, near or distant, and also the variations of the vertical line. The magnification is 100, and the period of oscillation of the tromometer can be extended to forty seconds. Attached to this instrument is an air-damping apparatus, by which the oscillations may be reduced, or even rendered aperiodical. Owing to its sensitiveness, this instrument is well adapted to the registration of earth tremors, pulsatory oscillations, and comparatively quick period earthquake vibrations.

"'The proposed new equipment, therefore, will be such as to enable us to make observations in connection with earthquakes, whether of a tectonic nature, or produced by volcanic action, as well as of other physical phenomena, such as earth tremors and pulsations, which may, as premonitory signs, have a bearing on the prediction of earthquakes. We are also prepared to study the relations that may exist between seismic disturbances, pressure and temperature.

"'While we can not make our studies cover the entire field of seismology, we believe our observations will be of considerable utility in the work that the Geological Society of America has undertaken.'

"The chairman of your committee has to report for his own district that, through the efforts of Professor J. B. Woodworth, Harvard University has installed a seismograph which is in active operation, and that money has been given by citizens of Boston whereby another Bosch-Omori instrument has been secured, and plans and drawings are now under consideration with a view to the building of a geophysical observatory near Boston which will be under the direction of the department of geology of the Massachusetts Institute of Technology."

The secretary reported from the council the constitution of W. B. Clark, H. E. Gregory, C. W. Hayes, J. M. Clarke and E. O. Hovey a committee to confer as to details with a committee of organization which had been chosen by certain paleontologists desiring to form a Paleontological Society as a section of and in close affiliation with the Geological Society of America, the council heartily commending the project. On motion the action of the council was endorsed and the committee given authority to act for the society.

The society then divided into two sections, as on Wednesday afternoon, and the following papers were presented under the chairmanship of President Calvin:

A Classification of Crystals based upon Seven Fundamental Types of Symmetry: CHARLES K. SWARTZ, Baltimore, Md.

A new and elementary development of the 32 groups of crystals was given, showing that all crystals fall into seven fundamental divisions based upon symmetry which are independent of the seven systems of crystals. Each of these types was characterized and a classification of crystals upon this basis was proposed. It is believed that the recognition of these divisions greatly simplifies the presentation of the subject of crystallography.

This paper was discussed by Professors W. H. Hobbs, E. H. Kraus, W. N. Rice and H. B. Patton.

The following paper was presented by title:

The Use of "Ophitic" and Related Terms in Petrography: ALEXANDER N. WINCHELL, Madison, Wis.

Then was read:

Chemical Composition as a Criterion in Identifying Metamorphosed Sediments: EDSON S. BASTIN, Washington, D. C. (Introduced by G. O. Smith.)

This paper called attention to the small number of definite statements, even of a qualitative char-

acter, in geological literature, as to the nature and value of chemical criteria in distinguishing schists of sedimentary from those of igneous origin. Quantitative statements are wholly wanting.

By compiling a large number of analyses of pelitic sediments the writer showed the nature of the chemical changes involved in their metamorphism. He then proceeded to contrast the composition of the pelitic schists and gneisses with that of their allies among igneous rocks. The calculation of the "norm" of a schist and its classification according to the quantitative system of Cross, Iddings, Pirsson and Washington was pointed out as a convenient method for making such comparisons.

These statistical studies brought out not only the character of the chemical criteria which may be used, but gave a quantitative measure of their value. The paper concluded with the application of these criteria to certain selected schist and gneiss analyses.

The discussion on this paper was participated in by Professors B. K. Emerson, W. S. Bayley, F. D. Adams and E. S. Bastin.

After this the following paper was read by title:

Petrology of the South Carolina Granites (Quartz Monzonites): Thomas Leonard Watson, Charlottesville, Va.

The next two papers, being on related topics, were presented in succession:

Tertiary Drainage Problems of Eastern North America: Amadeus W. Grabau, New York City.

The Laurentian River of Spencer carried the collected drainage of the Great Lakes through Ontario Valley and out by the way of the present St. Lawrence. The Finger Lake valleys and the Genesee are regarded as made by tributary northward flowing streams. Fairchild regards these as northward-flowing tributaries of a (possibly) westward-flowing river in the Ontario Valley. The author has in the past shown that a normal sequential drainage system, the general direction of which was northward, and in which the minor streams were beheaded by the master, accounted for all the topographic features of the region in question. Subsequent blocking of some of the channels by drift and deepening of others by ice, and a general depression of the country to the northeast, has produced the present drainage system. The problems were discussed in the light of accumulated facts.

Drainage Evolution in Central New York: H. L. Fairchild, Rochester, N. Y.

The paper aimed to assist in the elucidation of the complete physiography of the west half of New York State. Three maps represented graphically the general evolution of the drainage and the interference by glacier invasion of the normal stream development.

The first map showed the existing valleys which are an inheritance from the primitive (consequent) drainage, southwestward, across the uplifting coastal plain. These inherited valleys fall into three classes: (*a*) those in which the present flow is the same as the primitive, (*b*) those which are abandoned or left as "hanging" valleys and (*c*) those in which the stream flow has been reversed. A remarkable parallelism is exhibited by these valleys, which, except in the district of the Delaware and upper Susquehanna, are transverse to the present master streams. The primitive Susquehanna continued directly south at Lanesboro, instead of bending northwest as now, and occupied in Pennsylvania the Tunkannock Valley. Other valleys in northern Pennsylvania represent the continuation of the southwestward flow in central New York.

The second map exhibited the hypothetical Tertiary drainage. During Mesozoic and Tertiary time all the drainage of the west half of the state was diverted westward (subsequent) and northward (obsequent) into a great trunk stream that occupied the Ontario and Erie valleys and probably drained westward into the Mississippi basin. The cause of this radical reversion of flow was the great thickness of non-resistant rocks in the Ontario district. In the vertical series of strata between the Trenton and the Portage, on the Cayuga meridian, are 5,150 feet of rock of which 4,500 feet are weak shales, 350 feet limestone and 250 feet sandstone.

The pre-Glacial divide was far south in Pennsylvania. The Allegheny system poured north through the lower Cattaraugus Valley. The upper Genesee was tributary to the broad Dansville-Avon River, which almost certainly had its northward course through the Irondequoit Valley. The Susquehanna turned west from the site of Lanesboro and Susquehanna villages along the strike of the Chemung strata, which were less resistant than the overlying Catskill, past the sites of Binghamton, Owego and Waverly, and then curved north through the sites of Elmira and Horseheads and occupied the Seneca Valley. The Chemung was the principal tributary from the west, as to-day, but it passed north of Elmira instead of south, where it now lies in a post-Glacial cut.

The Delaware and the upper tributaries of the

Susquehanna were not diverted from their southwest courses.

Along the Ontario lowland the Tertiary channels are almost entirely destroyed or obscured by drift, but the valleys of Irondequoit, Sodus, Little Sodus and Fairhaven are trenches across the Niagara-Medina scarp which probably represent the northward pre-Glacial flow. To-day only two large streams pass across this rock ridge, the Genesee and Oswego, both in new channels. It seems probable that along the belt of Salina outcrop the pre-Glacial tributary streams flowed east or west as they do to-day.

It was suggested that the "oversteepened" walls of the bottom sections of the Finger Lakes valleys were produced by the rapid down-cutting of the streams during the Tertiary uplift.

The third map showed the principal stream flow as compelled by the ice sheets. A few strong south-leading valleys were enlarged or newly cut by the concentrated glacial waters, and the Allegheny and Susquehanna systems were turned to the south. In order from west to east the glacially developed valleys are Cassedaga, Conewango, Ischua, Canisteo, Cohocton, Cayuta, Cattatonk, Tioughnioga. These southeastward drainage lines, transverse to the primitive flow, were carved from numerous, short, subsequent valleys by stream flow forced to the southward by the ice-damming. Such flow was effective during the advance of the ice sheet, but stronger during the waning of the ice; and probably more than one ice invasion has been concerned.

On the Ontario lowland the forced drainage was west or east, alongside the ice margin. In the Erie basin the later flow was all westward past the ice front. In the Mohawk Valley the drainage between Little Falls and Rome was turned from west to east.

The water-parting which in pre-Glacial time lay in Pennsylvania has been so changed by glacial flow that it now lies close to the Finger Lakes.

These papers were discussed together by Professors A. W. Grabau, J. W. Spencer, F. Carney, A. P. Brigham, G. F. Wright, F. B. Taylor, A. P. Coleman and H. L. Fairchild.

At 12:40 o'clock the society adjourned for luncheon, meeting again at 2:05 o'clock to continue the reading of papers. President Calvin occupied the chair. The first two papers were read by title. They were:

Some Physiographic Features of the Shawangunk Mountains: GEORGE BURBANK SHATTUCK, Poughkeepsie, N. Y.

Nantucket Shorelines, III.: F. P. GULLIVER, Norwich, Conn.

Then was presented:

Nantucket Shorelines, IV.: F. P. GULLIVER, Norwich, Conn.

The writer has not been able to continue as fully as would have been desirable the detailed study of the island of Nantucket and its changing shoreline, on account of the cost of oft-repeated observation and survey. Some results of further study since the last report made to the society were given.

The strong north and northeast storms of the past fall have closed the Haulover, and the tombolo from Wauwinet to Coskata was completed on November 12, 1908. Some old maps have been studied with reference to the former eastward extension of the oldland at Wauwinet, Coskata and Folger islands. The changes on Great Point since 1896 were compared with previous conditions and with what may be expected in future. The shoals between Nantucket and Cape Cod, and between Nantucket and Martha's Vineyard and the Hyannis shore are considered as attempts of the sea to build tombolos.

After this was presented:

Note on Striations, U-shaped Valleys and Hanging Valleys produced by other than Glacial Action: EDMUND OTIS HOVEY, New York City.

The volcanic sand-blasts due to the eruption of Mt. Pelé produced striations and grooves in the material over which they passed that strongly resemble the striations and grooves produced by ice action. The heavily burdened streams of the Soufrière of St. Vincent have carved out rock channels of typical U-shape in the old lava flows of the volcano. Hanging valleys have been produced by the sea eroding more rapidly than the streams.

The paper was discussed by Professor A. Penck.

Then was read by title:

Historical Notes on Early State Surveys: GEORGE P. MERRILL, Washington, D. C.

The next paper was:

The Iron Ores of Maryland: JOSEPH T. SINGEWALD, JR., Baltimore, Md. (Introduced by W. B. Clark.)

This paper presented a brief summary of the results of an investigation carried on during the past season on the iron ores of Maryland under the auspices of the Maryland Geological Survey. Four classes of ore were recognized—limonite, hematite, magnetite and siderite. The paper presented embraced a discussion of the character and

chemical composition of each of these ores, the localities in which the deposits occur, and also their geologic and stratigraphic relations.

After this was presented:

The Shortage of Coal in the Northern Appalachian Field: I. C. WHITE, Morgantown, W. Va.

The next paper was read by title:

Glacial Character of the Yosemite Valley: FRANÇOIS MATTHES, Baltimore, Md. (Introduced by Wm. Bullock Clark.)

Then was presented:

The Mills Moraine with some discussion of the Glacial Drainage of the Longs Peak (Colorado) District: EDWARD ORTON, JR., Columbus, Ohio. (Introduced by F. P. Gulliver.)

This paper was discussed by Mr. W. T. Lee.

The next paper read was:

Quartz as a Geologic Thermometer: FRED E. WRIGHT and E. S. LARSEN, Washington, D. C.

Observations by Le Chatelier and Mallard in 1889–1890 proved that at about 570° quartz crystals undergo a reversible change, the expansion-coefficient, birefringence and circular polarization all changing abruptly. O. Mügge (*Neues Jahrbuch, Festband,* 1907, 181–196) has recently considered the problem again in detail and by means of etch figures combined with crystallographic behavior on heating found that below the inversion point quartz crystallizes in the trapezohedral-tetartohedral division of the hexagonal system, while above 570° it is trapezohedral-hemihedral. The high form is very similar to the low form and differs chiefly in the fact of its common planes of symmetry. A plate formed above 570° is trapezohedral-hemihedral, but on cooling it changes to the trapezohedral tetartohedral division, thereby losing its common planes of symmetry, which may then become twinning planes. It is to be expected, therefore, that quartz crystals thus cooled will be irregularly and intricately twinned after (1010.), while low temperature quartzes are simple or regularly twinned. It is furthermore evident, on considering the genesis of quartz at different temperatures, that intergrowths of right- and left-handed quartz are limited chiefly to quartz crystals formed below 570°. These two criteria can be used to distinguish quartz which has been formed or heated above 570° from quartz which has never reached that temperature. The object of the present investigation has been to test the general validity of the theoretical conclusions on a number of quartzes from different kinds of rocks and veins, as well as to determine more accurately the inversion temperature.

SECTIONAL MEETING FOR PAPERS ON STRATIGRAPHIC, AREAL AND PALEONTOLOGIC GEOLOGY

The section was called to order at 10 o'clock Thursday morning by Professor W. B. Clark, who was then elected presiding officer. Professor E. R. Cumings acted as secretary throughout, by request of the secretary of the society.

The first paper read was:

Occurrence of the Magothy Formation on the Atlantic Islands: ARTHUR BARNEVELD BIBBINS, Baltimore, Md.

The Magothy formation (of mid-Cretaceous age), as originally defined by Darton, was supposed by that author to be limited to the state of Maryland, although its partial equivalent, the "alternate clay-sands," was earlier mentioned by Uhler as occurring much farther northward. Recent investigations, paleobotanical and stratigraphic, by Hollick, Berry and the writer have extended the lines of the formation far southward, and northward across New Jersey and along the Atlantic Islands as far as Marthas Vineyard. The occurrence upon these islands was shown by local sections and photographs. The deposits are richly plant bearing, with grains of amber associated, as on the Magothy River. The formation suffered considerable corrugation by the great ice sheet.

The paper was discussed by Dr. David White and Professor A. B. Bibbins.

The next paper presented was:

Erosion Intervals in the Tertiary of North Carolina and Virginia and their bearing upon the Distribution of the Formations: BENJAMIN L. MILLER, South Bethlehem.

Recent investigations have furnished evidence of several uplifts and subsidences during Tertiary time in North Carolina and Virginia that have determined the present distribution of the formations. These have affected large areas at certain periods but at other times have been localized.

Then followed:

The Character and Structural Relations of the Limestones of the Piedmont in Maryland and Virginia: EDWARD B. MATHEWS and J. S. GRASTY, Baltimore, Md., and Charlottesville, Va.

A study of the small bodies of crystalline limestones and marbles found along the western edge of the Piedmont from Pennsylvania to North Carolina shows that their occurrences mark the tops of tightly compressed anticlines. The deposits on either side are usually metamorphosed volcanics—flows and tuffs—which in the normal

section lie far beneath the limestones. The areal distribution, contacts and structural lines point to a strong overthrust fault of wide extent.

This paper was discussed by Professor J. Barrell.

After this was read:

Recurrence of the Tropidoleptus Fauna and the Geographic Range of Certain Species in the Chemung of Maryland: CHARLES K. SWARTZ, Baltimore, Md.

The recurrence of *Tropidoleptus* and associated species of Hamilton type above the base of the Chemung of Maryland was noted. Certain diagnostic species of the Chemung, particularly those of the genera *Douvillina* and *Dalmanella*, appear to be of rare occurrence east of the Allegheny Front. The significance of this fact was discussed.

Discussion of the foregoing paper was participated in by Professors H. S. Williams, H. F. Cleland, Charles Schuchert, C. K. Swartz, J. M. Clarke, Stuart Weller, E. R. Cumings and C. S. Prosser.

Then was read:

The Geological Distribution of the Mesozoic and Cenozoic Echinodermata of the United States: WM. BULLOCK CLARK and M. W. TWITCHELL, Baltimore, Md., and Columbia, S. C.

The authors presented the results of an investigation of the Mesozoic and Cenozoic echinodermata of the United States, particularly in reference to the geological distribution of the forms studied. Representatives of the echinodermata are found at most horizons, but are numerous and significant in the Cenozoic and Tertiary rocks, where they at times become important forms for the determination of geologic horizons. The Upper Cretaceous formations both of the Atlantic and Gulf states have afforded a large number of important species.

The paper was discussed by Dr. J. M. Clarke and Professor W. B. Clark.

The next paper read was:

On the Age of the Gaspé Sandstone: HENRY S. WILLIAMS, Ithaca, N. Y.

A review of the evidences upon which has been based the opinion that the marine fauna at the base of the Gaspé sandstone is of the Hamiltonian epoch, and a presentation of the evidence for the view that these marine beds, as well as those of Pictou iron ore beds of Nova Scotia, Moose River sandstone of Maine and the upper beds of the St. Helen's Island conglomerate and of Côte St. Paul, are not of later age than the Oriskany beds immediately underlying the Onondaga limestone of North Cayuga, Ontario or Schoharie grit of eastern New York, at which epoch it is inferred marine connection with the Atlantic basin was cut off.

The Owl's Head and Chaudière River beds were explained by supposing the opening of a channel westward, connecting with Indiana basin and southwest at beginning of the succeeding Onondaga epoch.

The paper was discussed by Professors J. M. Clarke, Charles Schuchert, H. S. Williams and A. W. Grabau.

The section adjourned at 12:30 P.M. and met again at 2:15 P.M. with Professor W. B. Clark in the chair.

The following two papers were read by title:

The Aftonian Sands and Gravels in Western Iowa: BOHUMIL SHIMEK, Iowa City, Iowa.

An Aftonian Mammalian Fauna: SAMUEL CALVIN, Iowa City, Iowa.

Then was presented:

The Brachiopoda of the Richmond Group: AUGUST F. FOERSTE, Dayton, Ohio.

In the area dominated by the Cincinnati geanticline there have been several invasions of the brachiopoda considered most typical of the Richmond group. The first of these occurred near the middle of the deposition of the Arnheim bed. The Richmond group of the Mississippi Valley, as far as may be determined from a study of the brachiopoda, finds nearer representatives in the upper or Blanchester division of the Waynesville bed and in the Liberty bed, than in the Arnheim, lower Waynesville or Whitewater beds. A study of the distribution of the brachiopoda in Ohio, Indiana and Kentucky suggests that the centers of distribution lay more frequently toward the northeast than toward the northwest or west of the present areas of exposure. To account for this it is imagined that the Richmond group of the Ohio Valley was connected with that of the Mississippi Valley by way of northern Indiana and Illinois. Possibly, if the areas now covered by overlying formations could be exposed, the Richmond brachiopoda would be found to be absent in southern Indiana and Illinois and in western Kentucky, west of the present areas of exposure of these fossils in the region of the Cincinnati geanticline. Lithological conditions within the areas dominated by this geanticline favor this view.

Professor E. R. Cumings discussed this paper.

After this, the following paper was read:

The Trap Sheets of the Lake Nipigon Basin: ALFRED W. G. WILSON, Montreal, Canada.

The well-known trap sheets which form one of the most salient geologic features of the north shore of Lake Superior, are usually regarded as intrusive in origin and of the nature of laccolitic sills. In the basin of Lake Nipigon, lying north of Lake Superior, on the Laurentian peneplain, the trap sheets are found to rest either directly upon the Archean rocks or upon small outliers of the sediments, often many miles distant from the main areas of similar age. The traps are known to rest unconformably upon at least five different earlier formations. This unconformity can be explained by attributing to the fluid traps the ability to insinuate themselves, in an extremely intricate manner and over a very large area, between overlying sediments and underlying crystallines, here and there masses of the sediments remaining so firmly attached to the bed on which they rested that the traps flowed over and around them, cutting across the beds.

While many of the trap sheets along the north shore of Lake Superior are undoubtedly laccolitic sills, still the writer is inclined to believe that the balance of evidence shows that these sills are confined largely to the areas underlain by sediments of later date than the Archean. A simpler explanation, and one that appeals to the writer as more reasonable, of the relations known to exist between these trap sheets and the underlying rocks in the Nipigon basin, is that, at least along the line of the escarpments which mark the boundary between the sediments and the Archean areas to the north and out upon the old land itself, the same traps flowed over an eroded surface of subaerial origin.

Incidentally there is strong, though not conclusive, evidence for considering that these flows might be even of post-Cretaceous age.

This paper was discussed by Professors A. W. Grabau, A. W. G. Wilson, A. C. Lane and A. F. Foerste.

Then was read:

Reconnaissance in Arizona and Western New Mexico along the Santa Fé Railroad: N. H. Darton, Washington, D. C.

The reconnaissance was made for the purpose of ascertaining the prospects for deep wells to supply water to the railroad and settlements along its line. The region examined was from ten to forty miles wide and in this area the principal structural and stratigraphic features of formations from Cambrian to Cretaceous were determined.

This was followed by the reading of:

Geologic Studies in the Alaska Peninsula: Wallace W. Atwood. (Introduced by A. H. Brooks.)

Detailed work was done in the vicinity of Chignik, Balboa and Herendeen bays and on the Island of Unga. The Balboa-Herendeen Bay district was selected as a type area in the peninsula, and detailed studies were pursued in the hope of working out a key to the general geologic conditions of this portion of Alaska.

The formations exposed include the Upper Jurassic, Lower and Upper Cretaceous, marine and freshwater Eocene, Miocene, possibly some Pliocene, Pleistocene and recent Kenai plants were found associated with marine invertebrate shells of Upper Eocene age.

Vast quantities of igneous rocks have been intruded into the sedimentary series, and overlying a portion of the area there are volcanic tuffs and basic flows of post-Miocene age.

Coal occurs in the Upper Cretaceous and Eocene. Gold and copper prospects were examined at several localities.

Then was presented:

Present Knowledge of the Oklahoma Red Beds: Charles N. Gould, Norman, Okla.

After this was read:

The Fauna of the Fern Glen Formation: Stuart Weller, Chicago, Ill.

The Fern Glen formation is typically developed in St. Louis and Jefferson counties, Missouri, and Monroe County, Illinois. It lies at the summit of the Kinderhook group and consists of beds of red calcareous shales and red limestones, with a maximum thickness of about forty feet. The upper beds are more greenish in color and merge gradually into the superjacent Burlington limestone. The fauna is distinctly a member of the southern group of Kinderhook faunas and consists for the most part of corals, crinoids and brachiopods, with a few blastoids, molluscs and trilobites. Many of the species are undescribed, although more or less closely related to known forms in other Kinderhook faunas or in the Burlington limestone. The correlation of the fauna is with those of the basal Knobstone shales of Kentucky, the St. Joe marble of Arkansas and the Lake Valley beds of New Mexico.

The paper was discussed by Professors Charles Schuchert, Stuart Weller and E. O. Ulrich.

The next two papers were read by title:

Age and Geologic Relations of the Sankaty Beds, Nantucket: W. O. Crosby, Boston, Mass.

Age and Relations of the Sankaty Beds: H. W. SHIMER, Boston, Mass. (Introduced by W. O. Crosby.)

Then the following paper was read:

Some Features of the Wisconsin Middle Devonic: H. F. CLELAND, Williamstown, Mass.

This paper gave the results of a study of all the outcrops, as far as known, of the Wisconsin Devonic and their contained faunas. In it were discussed: (1) the relation of the strata to those above and below, (2) the unconformities, (3) the lithological characters and (4) the character, relationships and geographical distribution of the faunas.

Professors Charles Schuchert, A. W. Grabau and H. M. Ami participated in the discussion of this paper.

The next paper read was:

Ice-borne Bowlder Deposits in mid-Carboniferous Marine Shales: JOSEPH A. TAFF, Washington, D. C.

Great numbers of bowlders and other erratic fragmental rock débris occur in the Caney formation of the Ouachita Mountain region in southeastern Oklahoma. The erratic material consists of bowlders, cobbles and small rock fragments of three general classes, namely: (1) limestones, siliceous, argillaceous and magnesian; (2) flints, cherts and (3) quartzites.

The limestones are of various textures and colors, some of which partake of the nature of the quartzites, while others are argillaceous; others yet appear to be dolomitic or perhaps dolomites. Many of the limestone bowlders are massive and homogeneous, while others are distinctly stratified and contain two or more classes of limestone, or strata of limestone and flint.

Flint and chert bowlders are also of common occurrence, and in places are even more abundant than the limestone bowlders. Certain of these flints are stratified or bedded and are black or bluish in color, while others are massive, chalcedonic in character and contain inclusions of drusy quartz. Among these are many of conglomerate and brecciated nature.

The third group in the general classification of these erratics includes quartzites of dark and reddish hues.

These erratic bowlders vary in size from small pebbles to bowlders of enormous size, a few of which attain lengths of more than fifty feet. Many of the smaller bowlders are more or less rounded, while a few are quite perfectly so. The larger ones are, as a rule, angular.

At three separate localities in the Ouachita Mountain region certain of the limestone and flint bowlders contain grooves and striæ as if produced by the action of shore ice. Certain of these striæ also resemble the markings of slickensided surfaces. The evidence as to the origin of these gouged surfaces is not conclusive.

The erratic bowlders contain a comparatively abundant Ordovician and Silurian fauna. The bowlders are promiscuously scattered in the Caney formation of black and blue shale with local beds of sandstone in the upper part.

The Caney formation is several hundred feet thick and contains limy concretions or segregations, associated with the erratic bowlders and elsewhere, that contain an abundant fauna of late Mississippian or early Pennsylvanian age.

The area of bowlder-bearing beds of the Caney formation, as now known, is within the Ouachita Mountain uplift in Oklahoma that extends within a few miles of the Arkansas line to the west end near Atoka.

The structure of the region is typically Appalachian, the rocks being closely folded and thrust northward.

Upon comparison, both lithologically and faunally, the erratic bowlders are found to contain identical characteristics in the Cambro-Ordovician and Silurian rocks in the Ouachita Mountain region of Oklahoma and in the Cambro-Ordovician section in north-central Texas. There are evidences of emergence of the rocks of mid-Carboniferous time in the western part of the Arbuckle uplift and in the Texas region to the southwest that affect the Cambro-Ordovician and Silurian rocks. The tentative conclusion is that the bowlders were transported from a land to the south by the agencies of ice.

This paper was discussed by Messrs. David White, W. C. Alden and J. A. Taff.

The last paper on the sectional program was:

Relationships of the Pennsylvanian and Permian Faunas of Kansas and their Correlation with Similar Faunas of the Urals: J. W. BEEDE, Bloomington, Ind.

Owing to physical changes which occurred during the close of Pennsylvanian time, there occurred a great reduction of Pennsylvanian species, followed by the introduction of Permian species. This introduction of new species becomes very noticeable in the Elmdale formation and its base is considered the base of the Kansas Permian. The Permian, as here understood, includes the

Artinskian and "Permo-Carboniferous" of Eurasia.

REPORTS OF COMMITTEES

Through Mr. Arthur Keith the Committee on Geologic Nomenclature reported that it had organized by the election of Professor T. C. Chamberlin as chairman and Mr. A. Keith as secretary. The committee is constituted as follows:

For the Geological Society of America: Professors T. C. Chamberlin and W. B. Scott.

For the U. S. Geological Survey: Mr. Arthur Keith and Dr. David White.

For the Association of State Geologists: Dr. J. M. Clarke and Professor E. A. Smith.

For Canada—Geological Survey: Professor F. D. Adams. Other official surveys: Dr. W. G. Miller.

For Mexico: Dr. J. G. Aguilera and Dr. C. Burckhardt.

The Photograph Committee, Mr. N. H. Darton, reported that there had been few accessions during the year and practically no use of the collection.

On account of the length of the program the council formed a special section for the consideration of certain papers forming part of a symposium on correlation which had been arranged for by Mr. Bailey Willis, chairman, and Dr. F. P. Gulliver, secretary, of Section E (Geology and Geography) of the American Association for the Advancement of Science. For the sake of record the whole list of these papers, with the times when they were read, follows.

MONDAY, DECEMBER 28

Before Section E. (By title in G. S. A. program.)

Pre-Cambrian

11:00 A.M. to 12:10 P.M.

C. R. Van Hise: "Principles of Pre-Cambrian Correlation."

F. D. Adams: "The Basis of Pre-Cambrian Correlation."

Early and Middle Paleozoic

3:30 to 4:00 P.M.

C. D. Walcott: "Evolution of Early Paleozoic Faunas in Relation to their Environment."

4:00 to 5:50 P.M.

A. W. Grabau: "Physical and Faunal Evolution of North America in the Late Ordovicic, Siluric and Devonic Time."

4:50 to 5:30 P.M.

Stuart Weller: "Correlation of Middle and Upper Devonian and Mississippian Faunas of North America."

TUESDAY, DECEMBER 29

Before a temporary section of the G. S. A.

Late Paleozoic

11:00 A.M. to 12:05 P.M.

G. H. Girty: "Physical and Faunal Changes of Pennsylvanian and Permian in North America."

David White: "The Upper Paleozoic Floras, their Succession and Range."

Vertebrates

2:00 to 3:15 P.M.

S. W. Williston: "Environmental Relations of the Early Vertebrates."

H. F. Osborn: "Environment and Relations of the Cænozoic Mammalia."

Mesozoic and Tertiary

3:15 to 4:00 P.M.

T. W. Stanton: "Succession and Distribution of Later Mesozoic Invertebrate Faunas."

4:00 to 5:15 P.M.

W. H. Dall: "Conditions Governing the Evolution and Distribution of Tertiary Faunas."

Ralph Arnold: "Environment of the Tertiary Faunas of the Pacific Coast."

WEDNESDAY, DECEMBER 30

Before a temporary section of the G. S. A.

Tertiary and Quaternary

10:50 to 11:25 A.M.

F. H. Knowlton: "Succession and Range of Mesozoic and Tertiary Floras."

11:25 A.M. to 12:25 P.M.

R. D. Salisbury: "Physical Geography of the Pleistocene with Special Reference to Conditions Bearing on Correlation."

D. T. MacDougal: "Origination of Self-generating Matter and the Influence of Aridity upon its Evolutionary Development."

2:30 to 3:45 P.M.

T. C. Chamberlin: "Diastrophism as the Ultimate Basis of Correlation."

After the reading of scientific papers had been finished, the society met again in general session and Professor J. M. Clarke proposed a vote of thanks to the citizens of Baltimore, the authorities of the Johns Hopkins University and in particular to the members of the department of geology for the welcome accorded to the society and the particularly complete arrangements made for the work of the meeting and the comfort and enjoyment of those in attendance. The vote was

most heartily passed and was responded to by Professor W. B. Clark in behalf of the Baltimoreans concerned.

The society adjourned shortly before 5:00 P.M., on Thursday, December 31.

The following officers were elected by the society for the year 1909:

President—Grove K. Gilbert, Washington, D. C.

First Vice-President—Frank D. Adams, Montreal, Canada.

Second Vice-President—John M. Clarke, Albany, N. Y.

Secretary—Edmund Otis Hovey, New York City.

Treasurer—William Bullock Clark, Baltimore, Md.

Editor—Joseph Stanley-Brown, Cold Spring Harbor, N. Y.

Librarian—H. P. Cushing, Cleveland, Ohio.

Councilors (1909–1911)—George Otis Smith, Washington, D. C., and Henry S. Washington, Locust, N. J.

The following were elected as fellows of the society: Elliot Blackwelder, Madison, Wis.; William Phipps Blake, Tucson, Ariz.; Charles Wilson Brown, Providence, R. I.; Frank Carney, Granville, Ohio; Edward Salisbury Dana, New Haven, Conn.; Cassius Asa Fisher, Washington, D. C.; Albert Johannsen, Washington, D. C.; Geo. Frederick Kay, Iowa City, Iowa; Henry Landes, Seattle, Wash.; George Burr Richardson, Washington, D. C.; Joaquim Candido da Costa Sena, Ouro Preto, Minas, Brazil; Earle Sloan, Charleston, S. C.; George Willis Stose, Washington, D. C.; Charles Kephart Swartz, Baltimore, Md.

One hundred thirty-five fellows were in attendance, making this second Baltimore meeting the largest in the history of the society. The council voted to hold the next winter meeting in Boston and Cambridge.

EDMUND OTIS HOVEY,
Secretary

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 455th meeting was held February 20, 1909, with President Palmer in the chair. Dr. M. W. Lyon, Jr., exhibited the skins of two weasels from the vicinity of Washington, D. C. One was taken in the middle of the relatively mild winter of 1906–7 and showed the light brown pelage of long fur, characteristic of the winter pelage of weasels in this latitude. The other was taken in the latter part of March, 1904, and was mainly in the white winter pelage characteristic of weasels in higher latitudes. The middle line of the back showed the dark brown shorter summer pelage coming in. The winter of 1903–4 was colder than that of 1906–7. Whether that had anything to do with causing a white pelage instead of a light brown one could not be said.

The following communications were presented:

Some Japanese Entomologists and their Laboratories, with Notes on the Introduction of Parasites of the Gypsy Moth: L. O. HOWARD.

Dr. Howard spoke of some Japanese entomologists and their laboratories, and of the recent work in importing parasites of the gypsy moth and the brown-tail moth. He described some of the recent innovations in the large-scale experiment which has been carried on for three years by the Bureau of Entomology of the U. S. Department of Agriculture in the importation of parasites from Europe and from Japan, most of which have been mentioned in the annual report of the Chief of the Bureau of Entomology for 1908. He spoke especially of a trip to Japan taken during the summer of 1908 by Professor Trevor Kincaid, of the University of Washington (Seattle), as an agent of the bureau, to collect and send to the United States the Japanese parasites of the gypsy moth. This expedition was highly successful, and Mr. Kincaid met with the most gracious courtesy and the most hearty cooperation on the part of the Japanese entomologists. The talk was illustrated by lantern slides showing groups of Japanese entomologists at different agricultural colleges and experiment stations, as well as at private stations, and also of the experiment station buildings and laboratories.

Some Remarkable Phenomena Occurring in the Breeding of Varieties of Dianthus: J. B. NORTON.

Since 1904 several hundred seedling carnations have been grown each year by Mr. E. M. Byrnes, of the Bureau of Plant Industry, in the greenhouses of the Department of Agriculture. From the notes and records kept of these seedlings by the speaker, it was found that about 23 per cent. of the seedlings were typical single flowered, the remainder being double. The double flowers could be divided into two groups—standard doubles, *i. e.*, like the parent varieties, and full doubles, or "bull-heads"; the latter class averaging about 25 per cent. of the total number of seedlings. The close agreement of these percentages was that of a second generation of a Mendelian hybrid, which led to the prediction that the commercial carnation was a hybrid type and that the single and bull-head types were the extracted pure parent